

SAFETY INSTRUCTIONS FOR AA KICKERS AND SHUTTER DRIVE
SYSTEMS

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1. INTRODUCTION

The AA machine in building 193 has installed at various positions around its ring two kicker systems, two shutter drive systems, a magnet moving system as well as an oil cooling plant used with the kickers. This equipment is used during the antiproton injection, cooling and ejection phases of an AA cycle. These systems are referred to in the text as:

Injection kicker system (magnets, pulse generators, shutters)

Ejection kicker system (magnet, movement, pulse generator)

Pre-cooling shutter system

Auxiliary equipment (oil, gas, air etc.)

The injection kicker system consists of 10 (ten) individual injection kickers plus one spare which is not cabled or connected. This spare is mentioned because it is included in the equipment isolation procedure, in the case where it may one day be powered up for use. There is one ejection kicker which has associated with it the ejection magnet movement system.

The pulse generators of both the injection and ejection kickers are equipped with resonant charging high voltage power supplies capable of charging the individual, SF₆ gas filled, coaxial pulse forming cables to 80 kV in a few milliseconds. Each pulse generator can be completely isolated from its incoming 3 phase supply by means of a CASTELL key at the central distribution cupboard.

There are 4 (four) injection shutters and 8 (eight) pre-cooling shutters located around the ring. The positions of the kicker and shutter equipment in the ring is shown in Fig. 1. The oil cooling system with controls is positioned centrally to the kicker high voltage switchgear. This note describes the necessary precautions to be taken to obtain safe working conditions on any or all of the above mentioned equipment.

2. DESCRIPTION OF THE INJECTION KICKERS AND SHUTTERS

The injection kicker magnets and shutters are contained within the two vacuum tanks K3 and K4. Each magnet input is connected to its high voltage pulse generator with high voltage coaxial transmission cable pairs. The magnet outputs are connected to high power, oil cooled terminating resistors by the same type of cable. Fig. 2 shows the connection of the pulse generators to the magnets and terminating resistors. The sixth resistor in each array is a passive spare for each tank. The power for each complete module (pulse generator, low voltage control racks, magnet and resistor) is obtained from an individual 3 phase 25 A circuit in the auxiliary distribution cupboard BT1. This cupboard is found on the inside of the ring, on the Kicker Platform and between the drums of PFN cable (location A/22 on drawing AA.00.1010.0). Each of the fused 3 phase outputs are switched by Castell Key operated switches. The labelling of the Castell switches in the distribution cupboard BT1 are shown in Table 1. The incoming power feed for BT1 is derived from the departure point 5-3-1 of the sub station, zone K. The two shutters in tank K3 are powered from a single 3 phase Castell switched output in BT1, and likewise for the two shutters of tank K4. The electrical schematic of BT1 is shown in Fig. 3.

3. DESCRIPTION OF EJECTION KICKER AND MAGNET MOVING SYSTEM

The ejection magnet and its terminator form an integral assembly and are located in section 22. The ejection pulse generator is connected to the terminator and magnet by high voltage coaxial transmission cable. The magnet is moved horizontally inside the vacuum chamber via a servo motor driving a worm gear. Both the positioning control system driving the motor and the complete ejection pulse generator module are powered from a fused 3 phase circuit operated by a Castell key switch in distribution cupboard BT1. Detailed information of the connection is shown in Fig. 3 and Table 1.

4. DESCRIPTION OF PRE-COOLING SHUTTERS

The eight pre-cooling shutters are located in sections 4, 9, 16.1 and 16.2. The vacuum tank in each of these positions contains two shutters and each shutter is driven by a servo amplifier and motor system. The power for the pair of shutter drives for each tank is derived from a fused, 3 phase circuit operated by a Castell key switch. There are four independent 3 phase circuits for the pre-cooling shutter system in auxiliary distribution cupboard BT2. This cupboard is located inside the ring and facing the BT1 cupboard. Its location on drawing AA.00.1010.0 is B20. As well as the 40 A, 3 phase circuits for the pre-cooling shutters, BT2 contains two 25 A, 3 phase circuits for the servo controls and for a maintenance vacuum pump. The electrical schematic of BT2 is given in Fig. 4 whilst the labelling of the Castell key operated switches and rack connection numbers are given in Table 2. The incoming power feed for BT2 is obtained from the departure point 5-3-2 of the sub-station, Zone K.

5. DESCRIPTION OF THE OIL SYSTEM

All high voltage switchgear in the kicker modules, as well as their terminating resistors are cooled by pumping Diala C transformer oil through their sealed enclosures. The cooled oil is pumped around many closed oil circuits in parallel by a 3 phase pump and returns to the main storage tank via a common return pipe. There is also a second storage tank with permanently connected pipe work, which has two small pumps. This second system is used for filling or emptying modules during maintenance periods only. Both the controls for the main pumping system and that of the maintenance system are powered from a fused 3 phase circuit operated by a Castell key switch in the distribution cupboard BT1.

6. GENERAL SAFETY PRINCIPLES FOR WORKING ON AA KICKER AND/OR SHUTTER SYSTEMS

The systems comprise a variety of low and high voltage equipment as well as motor driven shutters. Because of the complexity and the large number of interconnections which exist between different parts of the systems and the very high voltages (up to 85 kV) which are present, certain principles must be laid down in order to guarantee safe working conditions during repair,

modification or maintenance. The application of these principles may result in more equipment being isolated than is strictly necessary for access to a particular part of one of the systems, but the principles must nevertheless be rigorously respected.

a) Work on tank equipment

No work may be performed on any ring installed tank equipment unless all the pulse generators driving that tank, the servo drives connected to its shutters or movement have been isolated. The Castell key(s) for that tank must be in the possession of the person executing the work.

b) Work on individual pulse generators

No work may be performed on any Pulse Generator Module (Injection Generators 1 to 10 or the Ejection Generator) until the module has been isolated from the electrical supply and its transmission cables have been unplugged at the generator and capped-off. The Castell key for the generator must be with the person doing the work.

c) Work on total system

No work may be performed on the complete AA kicker/shutter system until total isolation has been made at the incoming power distribution boards BT1 and BT2 and all Castell keys removed from these boards. These keys will be placed in the key press in the cabin which is then locked. The person responsible for the work being executed will keep this key.

d) Incomplete isolation precautions

In the absence of a complete isolation according to c) above, certain electronic chassis, not specifically associated with individual pulse generators or servo drives and which may be supplied with power from remote parts of the system, must be considered live until isolated by removal of all ingoing and outgoing cable connectors. Care should also be exercised in certain shutter drive control racks where unprotected 3 phase, 380 V, 50 Hz conductors are to be found.

e) System security interlocks

The system contains a certain number of HT and LT interlocks which are intended to prevent damage to equipment in the event of careless or faulty operation. Under no circumstances are these interlocks to be relied upon to provide a safe environment for maintenance or repair work.

f) Other ring equipment

Safe working conditions as defined in this note relate only to the isolation of the injection and ejection kicker systems, the injection and pre-cooling shutter drives and the oil cooling system. Any other equipment of the ring magnet tanks, such as vacuum pumps etc. must be considered energised until isolated by procedures appropriate to that equipment.

7. SAFE WORKING WHEN CHANGING INJECTION KICKER POLARITY

To obtain safe working conditions when changing the injection kicker polarity at the ring magnets the following procedure must be used.

- a) Isolate all injection pulse generators (modules 1 to 10) by removing Castell keys K01 to K10 from BT1.
- b) Isolate both injection shutter drives by removing Castell keys K15 and K16 from BT1.
- c) Use Castell key K11 to release keys KX and KY from the small exchange box near BT1.
- d) Insert keys K01 to K05, K15 and KX into the transfer exchange box KT3 and remove and retain the K3 tank master key KT3.
- e) Insert keys K06 to K10, K16 and KY into the transfer exchange box KT4 and remove and retain the K4 tank master key KT4.
- f) The keys KT3 and KT4 must remain in the possession of the person doing the polarity changing and must only be replaced in the transfer exchange box when the work is terminated and the equipment safe to re-energise. It should be noted that tanks K3 and K4 are equipped with standard CERN "Danger, High Voltage" signs. These signs are normally illuminated and

flashing and therefore indicate that KT3 and KT4 keys have not been removed from the transfer exchange boxes. Extinction of the signs however should not be taken to mean that the equipment has been made safe and is not a substitute for possession of keys KT3 and KT4.

8. SAFE WORKING ON INJECTION KICKER TANKS K3 AND/OR K4

To obtain safe working conditions on a particular injection kicker tank, including work on the terminating resistor array directly behind each tank, the following procedures must be used.

- a) To work on tank K3, remove keys K01 to K05, K15 from BT1 and insert together with KX into the transfer exchange box KT3 and remove and retain the K3 tank master key KT3.
- b) To work on tank K4, remove keys K06 to K10, K16 from BT1 and insert together with KY into the transfer exchange KT4 and remove and retain the K4 tank master key KT4.
- c) To work on tanks K3 and K4 apply the procedures of both a) and b) above.
- d) In addition if work has to be done on a servo motor drive assembly, the balancing air pressure must be reduced to zero and each shutter blade allowed to descend to its lowest level before removal of the safety guards on the pistons and drive belt.
- e) The keys must remain in the possession of the person doing the work on the tanks and must only be replaced in the transfer exchange boxes when this is terminated and all safety guards have been replaced and the equipment safe to re-energise.

9. SAFE WORKING ON THE EJECTION KICKER TANK K22

To obtain safe working conditions on the ejection kicker tank K22 the following isolation procedure is to be used.

- a) Remove and retain key K12 from the distribution cupboard BT1.
- b) This key is to be held in the possession of the person working on K22 tank equipment and must only be replaced when the work is terminated and the equipment safe to re-energise.

Tank K22 is equipped with a standard CERN "Danger High Voltage" sign which is normally illuminated and therefore indicates that K12 key has not been removed from BT1. However extinction of this sign should not be taken to indicate that the equipment has been made safe and is not a substitute for possession of key K12.

The key K12 also isolates the ejection magnet movement system to permit work on the drive motor or mechanics.

10. SAFE WORKING ON SHUTTER SYSTEMS

In general, safe conditions for work to be executed on injection shutters are obtained by following the procedures laid out in section 8c of this note. However, in certain circumstances work may have to be done on a partially isolated shutter system (injection or pre-cooling) in which case the procedure in section 12 is to be followed. The injection shutters are powered from switched, fused circuits in cupboard BT1. Table 1 shows which rack is powered from each of these switched circuits. The pre-cooling shutters are powered from switched, fused circuits in distribution cupboard BT2. Table 2 gives the Castell key number and the racks containing the servo systems which are isolated.

a) Pre-cooling shutter isolation

For complete isolation of all pre-cooling shutters the following Castell keys must be removed from BT2; K17, K18, K19, K20 and K21.

b) Injection shutter isolation

Complete isolation of the injection shutter system entails removing keys K15, K16 and K21.

c) Complete shutter system isolation

The procedures in a) and b) above are to be completed. In all cases the Castell keys removed for isolating equipment must be retained by the person doing the work and only replaced when it is sure that the equipment is safe to re-energise.

11. SAFE WORKING ON THE OIL SYSTEM

Removal of Castell key K13 will completely isolate the main pump controls and maintenance control station. The person working on any part of the oil system must retain this key in his possession. The key must only be replaced in BT1 when the work is terminated and the system safe to re-energise. When K13 key is removed this will stop all kicker modules from working, however, the flashing "Danger High Voltage" signs on K3, K4 and K22 and the switchgear platform will continue to flash.

12. SAFE WORKING WITH THE KICKER AND/OR SHUTTER SYSTEMS
PARTLY ENERGISED

Since all of the kicker and shutter drive hardware is in the AA Hall there is no possibility of making repairs to parts of the equipment whilst the machine functions normally. However, under certain circumstances, when there is access to the machine, repair work may have to be executed on one or more kicker modules or shutter drives with the others working on test. In this case a risk of low voltage contact exists and the work must be executed by a licenced operative in the presence of at least a licensed assistant as defined in the CERN safety regulations. In order to eliminate the risk of high voltage and to minimise the risk of low voltage contact the following procedures must be strictly adhered to.

- a) Isolate the correct kicker module or shutter drive by removal of the Castell keys appropriate to the equipment (i.e. to work on module 9 remove key "K09"). Refer to Tables 1 and 2 to be sure that you have isolated the correct equipment. Personally retain these keys until the modules are safe to re-energise.
- b) Verify by inspection that the supply racks pertaining to the modules or shutter drives to be worked on (refer to Tables 1 and 2 for equipment rack numbers) are de-energised and in the case of kicker modules that the capacitor banks in these racks are discharged.
- c) Where work has to be done on a kicker module, temporarily stop all other modules from pulsing by switching to OFF their "SORENSEN" power supplies, discharging their capacitor banks and setting the "LOCAL HT SWITCH" on the interlock unit to 'OFF'.

- d) Locate the two red flexible coaxial high voltage cables connected to the outputs of the Main Switch (MS) of the modules to be worked on. Unplug these cables from the MS and cap them off with the earthed brass caps provided. The HT interlock plug, connected to the cables by a chain has first to be unplugged, ensuring that the HT interlock chain is broken. Work on the module or modules thus de-energised may now proceed, and the other modules concerned in c) allowed to pulse.
- e) If during repair work any parts normally at high tension become exposed these should be earthed with the earthing rods installed on the kicker platform. Permanent earthing cables can then afterwards be connected remembering to always connect one end to ground before connecting it to the component. After the repair all temporary earth connections and earthing rods must be removed before applying any power to the module.
- f) Re-read and take action if necessary concerning point 6 d) of these instructions.
- g) Disconnection of motor cables from the servo motor causes the drive to trip to an 'OFF' state. This however, does not constitute a safe working condition for that drive which must be isolated using the appropriate Castell key.

13. "DANGER, HIGH VOLTAGE" SIGNS AND THEIR CONNECTION

The "Danger, High Voltage" signs in the systems described in this note are directly related to the kicker modules.

Injection kicker magnets and shutters in the same tank are power interlocked with their individual Castell keys. For certain combinations of these keys being present in each transfer box, and the transfer key removed, the flashing signs on these tanks are switched off. Below is a table showing the normal conditions under which a flashing danger sign is 'OFF'. However, for any equipment to be safe it is not sufficient for the 'Danger' sign to be 'OFF', the Castell key for that equipment or for the tank upon which work is to be executed must be in the possession of the person doing the work.

The 'Danger' signs are located on tanks K3, K4, K22 and also at both ends of the switchgear platform.

Danger Sign	Danger sign lamp 'OFF' conditions	
K3 tank	K01, K02, K03, K04, K05 with KT3 K15, KX in KT3 transfer box and key removed	or with key K14 removed
K4 tank	K06, K07, K08, K09, K10 with KT4 K16, KY in KT4 transfer box and key removed	or with key K14 removed
Switchgear platform	K14 key removed	
K22 tank	K12 key removed	

The block schematic diagram of Fig. 5 shows how these 'DANGER, HIGH VOLTAGE' signs are connected to the Castell key controlled a.c. power sources.

14. TOTAL ISOLATION OF KICKER AND SHUTTER SYSTEMS

a) Total isolation from the sub-station

Total isolation in this context means that both power distribution cupboards BT1 and BT2 are de-energised thus permitting work on them.

This can only be achieved in the sub-station zone K next to the AA control room (ACR).

The **outgoing** three phase circuits for both BT1 and BT2 must be switched 'OFF' and locked with locks provided in the sub-station for this purpose. A sign must be placed on the disabled circuit indicating that work is in progress and the key for the locked circuit put back into the key press. This action can only be undertaken with the authority and under the supervision of the EIC of the ACR who keeps in his possession the key giving access to the key press.

b) Total isolation in the ring

To isolate the kicker and shutter equipment totally in the AA ring at the distribution cupboards BT1 and BT2 the following procedure must be used.

Remove all Castell keys from BT1 and BT2 (i.e. keys K01 to K22).

All keys removed from BT1 and BT2 will be put into the key press in the cabin in the centre of the ring and the key press locked. The person responsible for the work being executed will keep the key in his possession and will inspect each zone of the system to ensure that it is safe to re-energise before replacing any Castell key.

15. PERSONS AUTHORISED TO ISOLATE THE AA KICKER/SHUTTER SYSTEMS

The following is a signed list of the persons authorised to isolate, in whole or in part, the AA kicker/shutter system for safe working to proceed.

D. Fiander
K.D. Metzmacher
P. Pearce
H. Schroot
H.S. Simpson
D. Rosset

By their signature these persons confirm that :

- a) They have adequate knowledge of the system to allow them to isolate it without danger and bring it to a state for safe working.
- b) They have read and fully understood and are in possession of a copy of these instructions.

If work has to be carried out on part or the whole of the AA kicker and shutter drive systems by any person other than those listed above the following procedure will apply :-

- i) Isolation and necessary earthing must be carried out by one of the named persons.
- ii) This person will assume personal responsibility for all other persons working on the equipment.
- iii) If the responsible person does not remain full time at the scene of the work he will hand over the key(s) which guarantee the continued isolation of the equipment to the person working on the equipment. This latter will return the key(s) only to the person from whom he received them.

Distribution :

R. Billinge	B. Pincot
D. Bloess	A. Poncet
J. Ganosa	P. Riboni
E. Jones	C. Rufer
H. Koziol	R. Stähli
F. Malthouse	B. Williams
S. Milner	Kicker Projects Section
B. Nicolai	

TABLE 1

AUX. BT. NO. 1

(Powered from depart 5-3-1 sous-station zone K

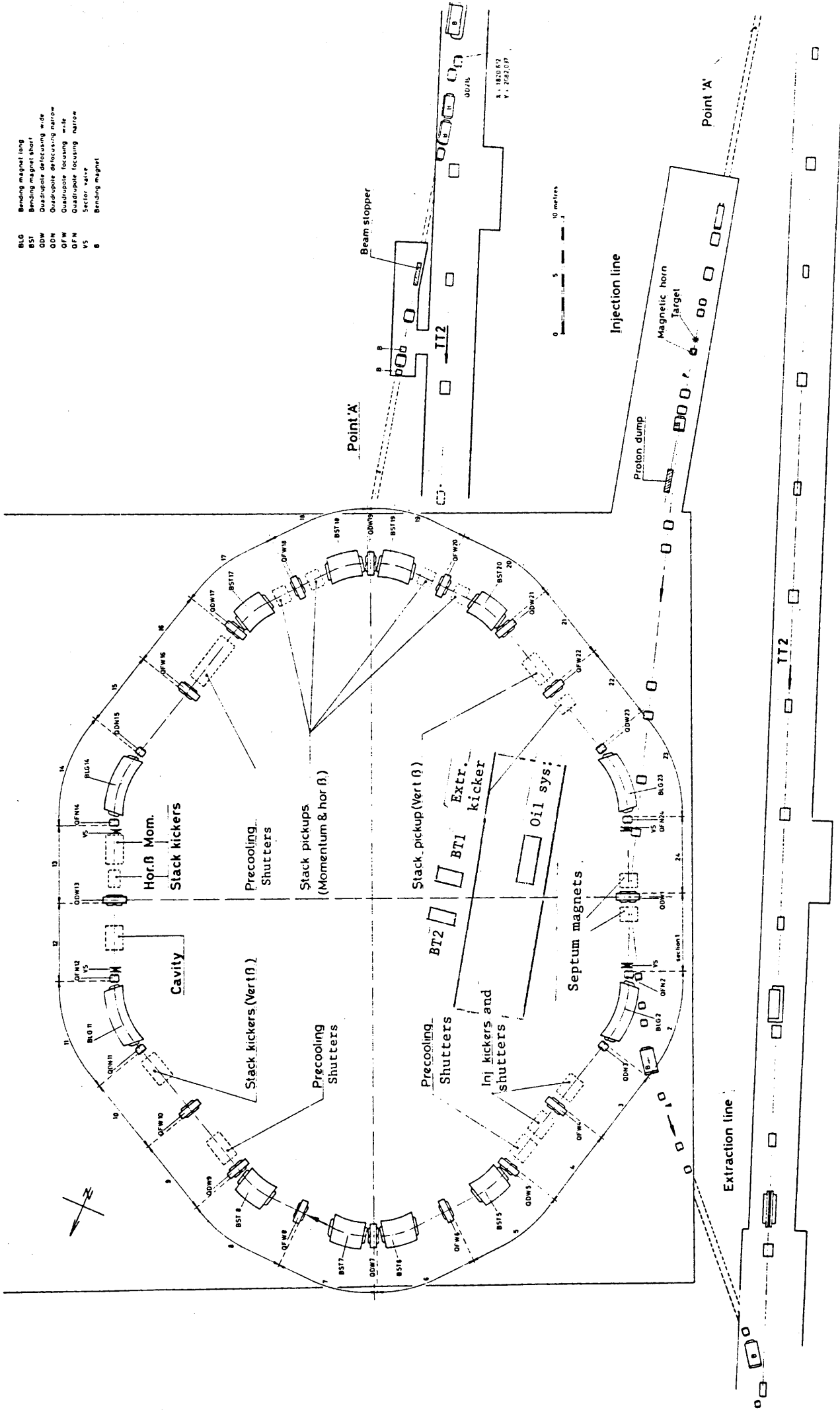
Circuit No.	Equipment Identification	Fuse rating	Castell key	Connected to racks	Safety remarks
1	Inj. Mod 1	25 A	K0 1	B001,2	} K3 tank modules
2	2	"	2	B003,4	
3	3	"	3	B005,6	
4	4	"	4	B007,8	
5	5	"	5	B009,10	
6	6	"	6	A016,17	} K4 tank modules
7	7	"	7	A018,19	
8	8	"	8	A020,21	
9	9	"	9	A022,23	
10	10	"	K 10	A024,25	
11	Reserve	"	11	A028,29	
12	Ejec. module Ejec. movement	"	12	A026,27 A2110	← Feeds flashing HT
13	Oil system kicker	"	13	A014	Warning light on K22
14	Kicker CNTRS + Monit.	"	14	A014	← Feeds flashing HT
15	Inj. servo K3	32 A	15	B0310	Warning lights on K3, K4 and platform.
16	Inj. Servo K4	32A	16	B0308	

TABLE 2

AUX. BT. NO. 2

Powered from depart 5-3-2 sous-station zone K

Circuit No.	Equipment Identification	Fuse rating	Castell key	Connected to racks	Safety remarks
1	KPM 4	40 A	K 17	B0402	
2	KPM 9	"	K 18	C1002	
3	UPM 16.1	"	K 19	D1605	
4	UPM 16.2	"	K 20	D1607	
5	Servo CNTRS. + monitoring	25 A	K 21	A013	
6	Vacuum pump	25 A	K 22	Vacuum pump	



- BSL Bending magnet long
- BST Bending magnet short
- ODW Quadrupole defocusing wide
- ODN Quadrupole defocusing narrow
- OPW Quadrupole focusing wide
- VS Quadrupole focusing narrow
- B Sector valve
- B Bending magnet

Fig.1 General Layout Of The Antiproton Accumulator

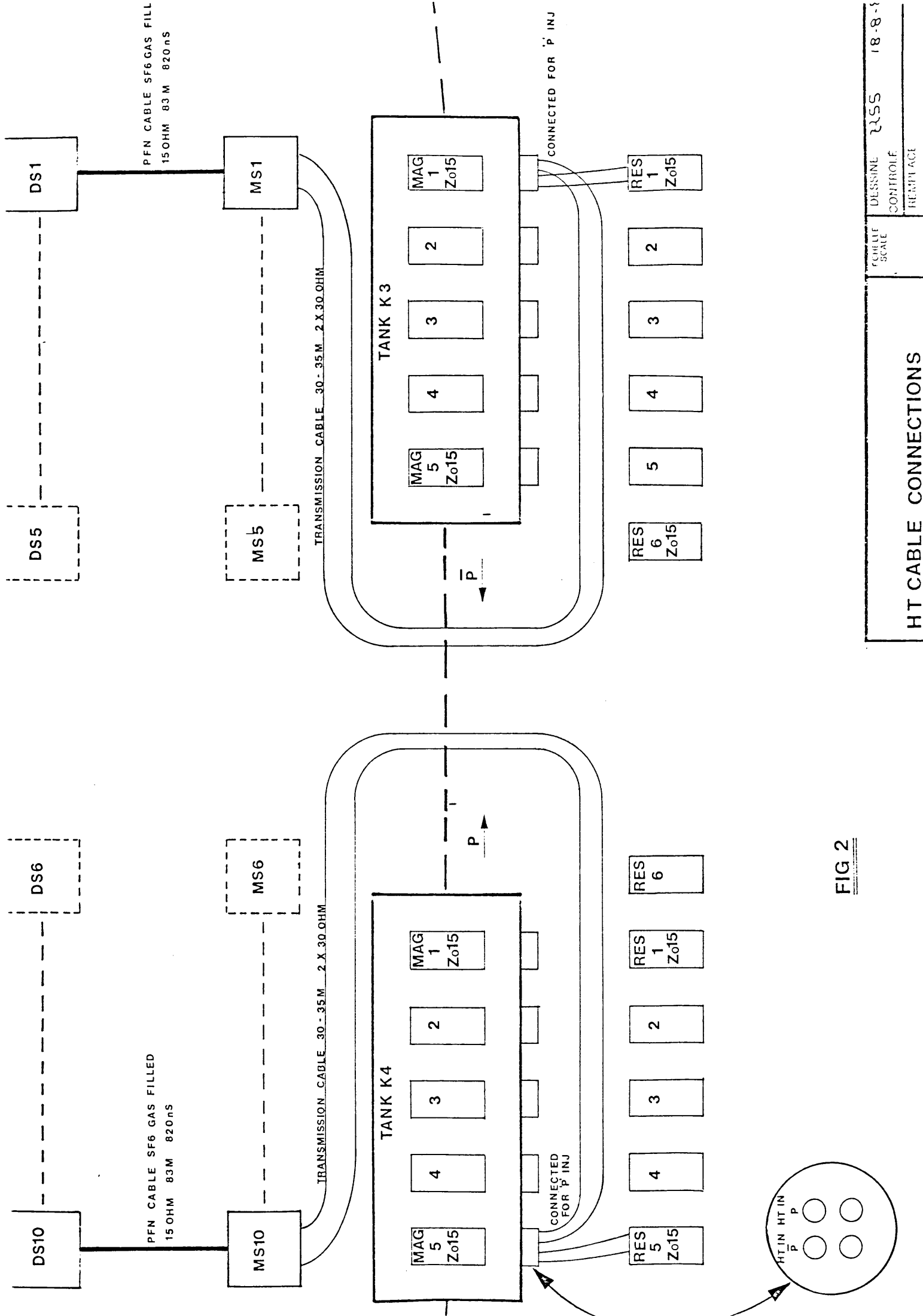


FIG 2

HT CABLE CONNECTIONS

DÉPART 5-3-1 DE LA SOUS-STATION ÉLECTRIQUE, ZONE K

4 x 1 x 240³ Al (225 025 ... 225 028)
1 x 150 Cu



INTERRUPTEUR GÉNÉRAL
4 x 250 A
"SIRCO"

(3 PH+N) 380/220V

INTERRUPTEUR-FUSIBLE
"FUSOBLOC"

COUPE - CIRCUIT HPC

INTERRUPTEUR
VERROUILLABLE
"CASTELL"

BORNES 10²
DÉPART N°.

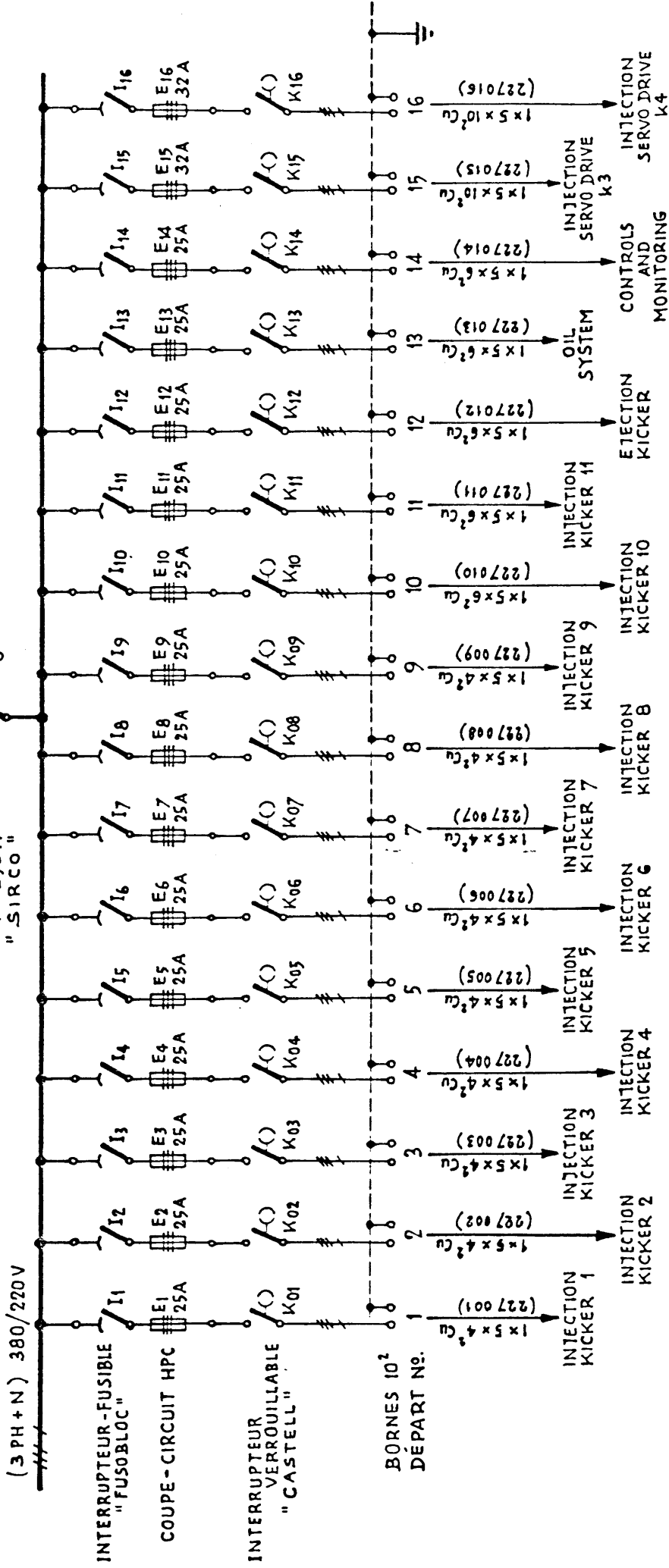


TABLEAU AUXILIAIRE BT N° 1

ELECTRICAL DISTRIBUTION 380/220V~
FOR INJECTION AND EJECTION KICKER MAGNETS AND SHUTTER DRIVES

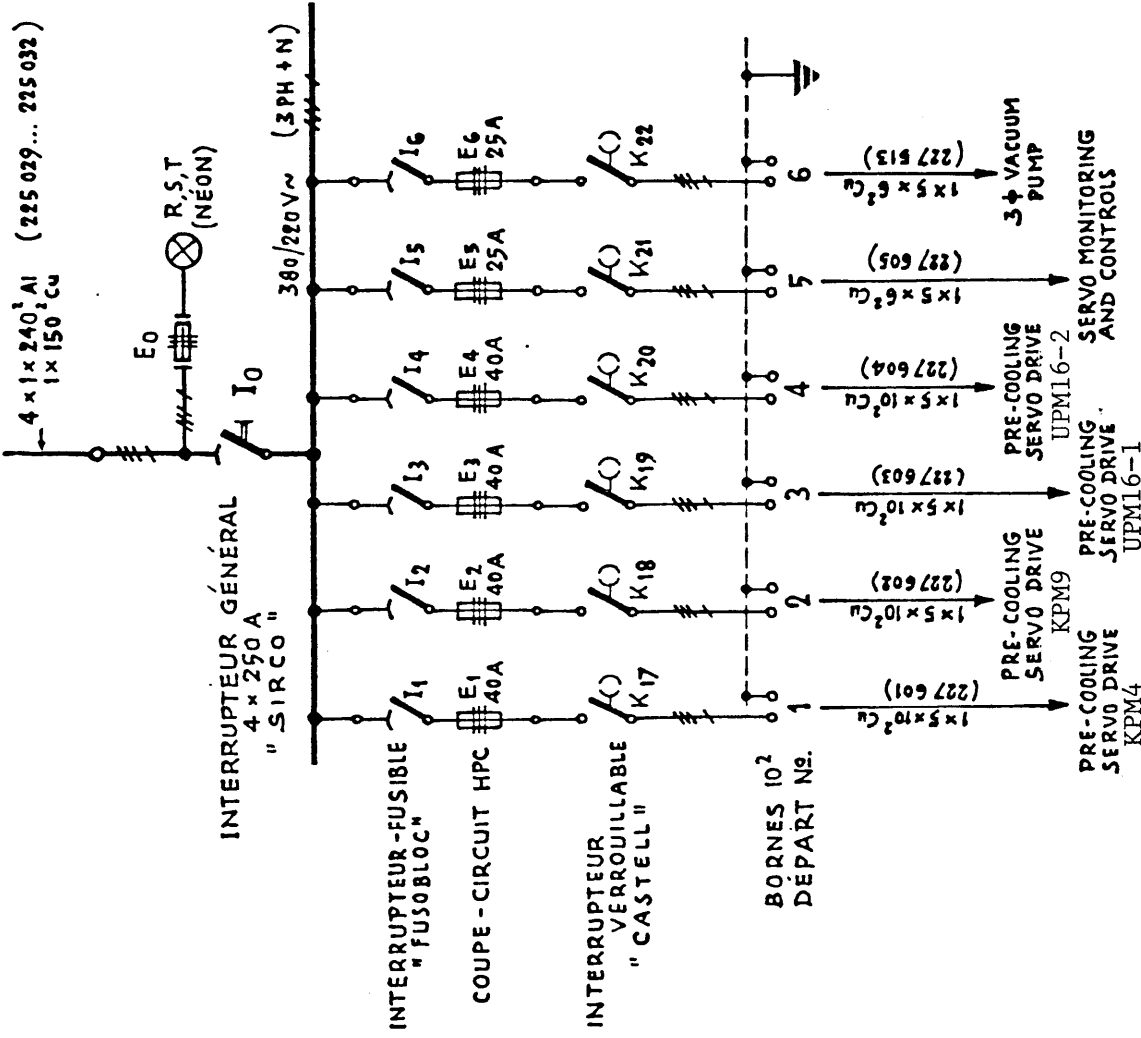


TABLEAU AUXILIAIRE BT N°2

ELECTRICAL DISTRIBUTION 380/220V~
FOR PRE-COOLING SHUTTER DRIVES

This drawing may not be used for commercial purposes without written authorisation
 commerciales sans autorisation écrite

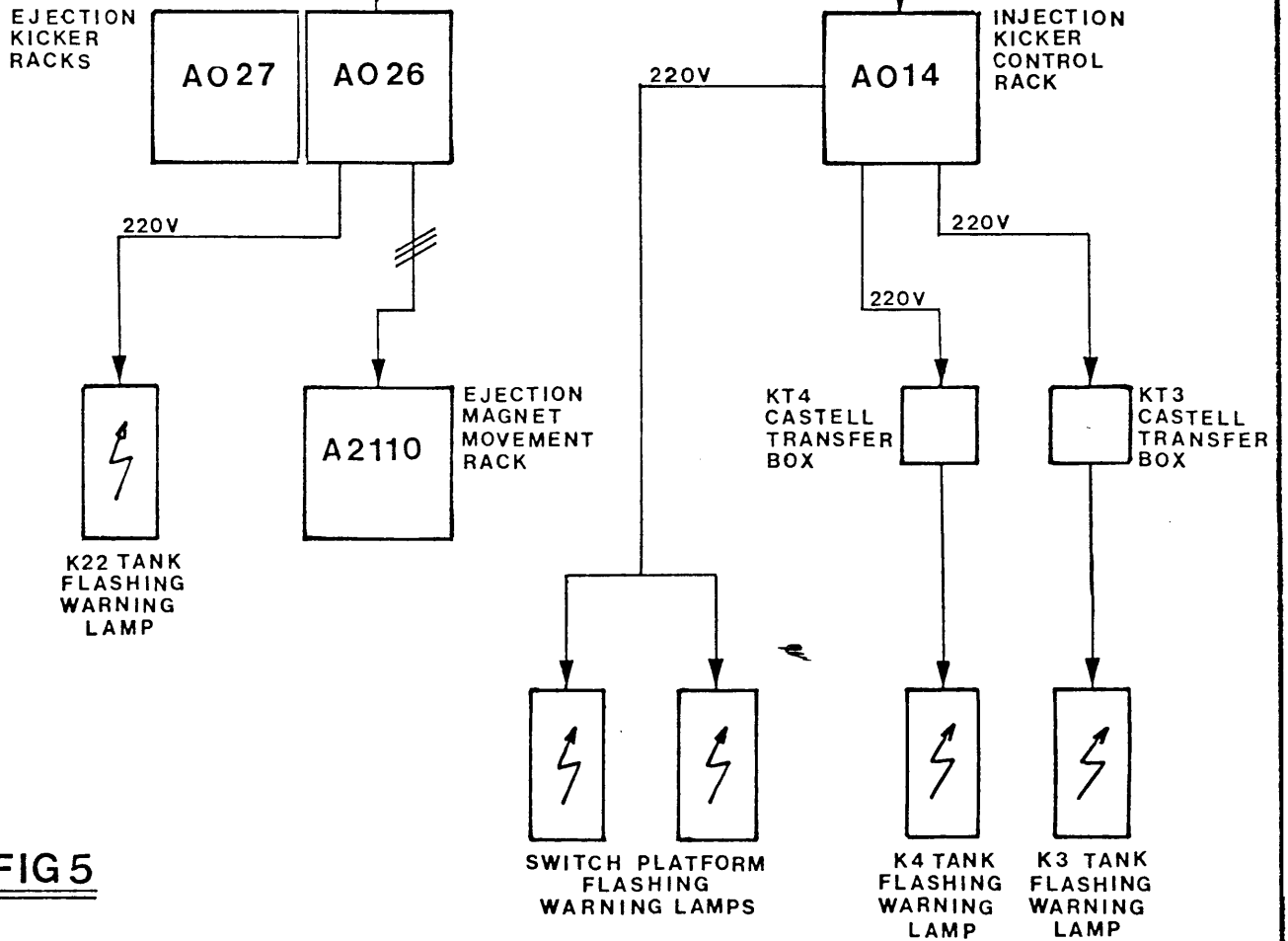
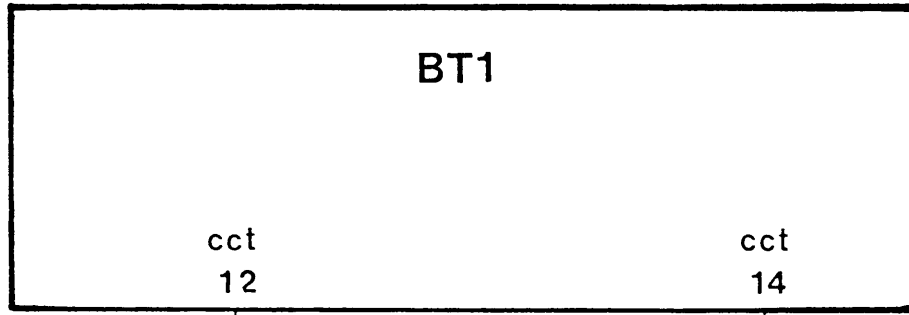
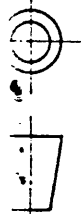


FIG 5



First angle projection
 Projection européenne

Ensemble Assembly		S/ensemble S/assembly		Nom-Name		Date	Issue
P P		Echelle Scale		Dessiné R55	18-8-81		
220V DISTRIBUTION FOR FLASHING WARNING LAMPS				Contrôlé			A
							B
							C
ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH CERN LAB 1... CH-1211 GENÈVE 23				A - 22 - 7088 - 4			